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ENSO dynamics in the quasi-fast-wave approximation.

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Most of the processes that control ENSO dynamics and sea surface temperatures in the tropical Pacific are relatively fast. For instance, it takes 1-2 months for the SST to respond when the thermocline slope or the strength of equatorial upwelling increases; it takes T_k = 2 months for a Kelvin wave to cross the Pacific basin (and about half-a-year for a Rossby wave). A tracer moving with the zonal current will be advected from the eastern to the central Pacific in about 4-5 months. Compared to such short timescales the characteristic period of ENSO (T = 3-5 years) is much longer. In the present study we take advantage of this fact and use the smallness of the ratio ϵ = T_k /T to derive what we call the quasi-fast-wave approximation. Using this approximation the simplified equations of ENSO dynamics are formally obtained by expanding the primitive equations into power series of ϵ. The proposed approach allows adding various relevant processes to the theory in a uniform fashion and provides a convenient tool to unify different conceptual models of ENSO, including the broadly used delayed and recharge oscillator models. A particular result of the study is that oceanic damping rates are one of the crucial factors in controlling the amplitude and periodicity of El Niño.